

SECTION 11 5311.17

GLOVEBOX INSTRUMENTATION

LANL MASTER SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the LEM Mechanical POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Information within “stars” is provided as guidance to the author responsible for revising the specification. Delete information within “stars” during editing.

This specification serves as a template. The specification was prepared by an organization operating under a quality assurance program that meets the requirements of 10 CFR 830 (suitable for ML-1 through ML-4 projects). Implementation of this specification requires modification to the specification to meet project-specific requirements. Responsibility for application of this specification to meet project-specific requirements lies with the organization modifying or implementing the specification. The organization modifying the specification shall apply a graded approach to quality assurance based on the management level designation of the project. When this specification is used with nuclear facilities subject to 10 CFR 830, modification to this specification must be performed by an individual or organization operating under a quality assurance program that meets the requirements of that CFR.

Specification developed for ML-3 / ML-4 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Fire detection systems
2. Moisture analyzers
3. Oxygen analyzers
4. Pressure instruments
5. Temperature instruments
6. Hydrogen chloride monitors
7. Hydrogen fluoride monitors
8. Chlorine monitors
9. Hydrogen monitors
10. Miscellaneous glovebox instrumentation

B. Scope

1. This section establishes the technical requirements for the materials of construction, manufacturing, testing, shipment, and quality assurance (QA) of glovebox instrumentation installed at LANL.
2. This section applies to new instruments associated with a glovebox or other glovebox related processes.

 Modification of a glovebox or glovebox related process requires re-evaluation of the currently installed instruments. If the currently installed instruments do not meet the requirements of this section, replacement may be required.

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C. Related Sections

1. Section 01 3300, Submittal Procedures
2. Section 01 2500, Substitution Procedures
3. Section 11 5311.16, Glovebox Feedthroughs, Hermetically Sealed
4. Section 11 5311.18, Glovebox Atmosphere Regenerable Purification Systems
5. Section 11 5311.10, Glovebox Fabrication
6. Section 11 5311.12, Glovebox Installation

1.2 REFERENCES

A. General

1. The standards and specifications designated below are a part of this specification to the extent specified herein. The most current revisions of standards and specifications apply. In the event of a conflict between provisions of this section and provisions of the referenced documents, the text of this section takes precedence.

B. American Society for Nondestructive Testing (ASNT)

1. ASNT-TC-1A, Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing

C. ASTM International (ASTM; formerly American Society for Testing and Materials)

1. ASTM E 499, Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector in the Detector Probe Mode

D. Code of Federal Register <http://www.access.gpo.gov/nara/cfr/cfr-table-search.html>

1. 10 CFR 830.122, Quality Assurance

E. International Organization for Standardization

1. ISO 9001, Quality Management Systems Requirements

F. Los Alamos National Laboratory

1. LANL drawing 26Y-202010

2. CMR-SDD-007, R00, Chemistry and Metallurgy Research Facility System Design Description
3. NMT-8-ASI-006, Fire Alarm Initiating Device Inspection, Maintenance, and Testing.

1.3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

ASME: American Society of Mechanical Engineers

ANSI: American National Standards Institute

CFR: Code of Federal Regulations

CMTR: Certified Material Test Report

EIA: Electronics Industries Association

FACP: Fire Alarm Control Panel

LEL: Lower Explosive Limit

lpm: Liters per Minute

mA: milliamperes

MNPT: Male National Pipe Thread

NIST: National Institute of Standards and Technology

NPT: National Pipe Thread

POC: Point of Contact

ppm: Parts per Million

psig: Pounds per Square Inch Gauge

QA: Quality Assurance

SCFH: Standard Cubic Feet per Hour

Std cc: Standard Cubic Centimeters

UL: Underwriters Laboratory

VAC: Volts Alternating Current

VCR: Metal gasket face seal fitting manufactured by Crawford Fitting (Cajon series)

VDC: Volts Direct Current

w.c.: Water Column

1.4 SYSTEM DESCRIPTION

- A. Instruments shall be suitable for service at 7,500 feet elevation above sea level. Any service derating factor that applies due to use at high altitude shall be provided to LANL by the Supplier.

1.5 QUALITY ASSURANCE

A. Seller's Quality Assurance Requirements

- 1. As used in this document, QA is intended to control a combination of materials, preparation, fabrication, inspection, testing, cleaning, packaging, and shipping to be done to ensure the protection of an acceptable finished product. Maintain a QA program in accordance with 10 CFR 830.122 or equivalent. LANL approval is required for the supplier's QA program.
- 2. Instruments with an electrical input or output shall be UL listed.

B. Receipt Inspection

- 1. Upon receipt the instrument will be visually inspected for cracks, dents, and other abnormalities that could affect the accuracy of the instrument.
- 2. Calibration and material certifications listed below will also be checked.

C. Calibration & Material Certifications

- 1. Instruments to be calibrated by manufacturer. Calibration shall be traceable to NIST standards.
- 2. Additional instrument calibration used for Pit Manufacturing to be done by LANL.
- 3. Calibration documentation to be included with the instrument at time of delivery.
- 4. Material certification for all process-wetted materials to be included with the instrument at time of delivery.

D. Storage & Handling

- 1. All openings shall be capped, plugged or otherwise sealed against the intrusion of water, dirt and debris. Water shall be removed from cavities to protect against damage caused by freezing, and desiccant inserted if appropriate.
- 2. Instruments shall be handled with reasonable care to prevent damage to the instrument before installation.

E. Personnel Qualification

- 1. Personnel installing instrumentation shall be familiar with type of instrument and required installation practices. Refer to vendor's QA plan for additional requirements for installation personnel.

F. Nonconformances

1. Nonconformance of an instrument shall be documented and corrected before shipment; if found on receipt before installation.

G. Leak Testing

1. Provide helium leak test procedure per ASTM E499. Pressure during helium leak test to be +10 inches W.C.

1.6 SUBMITTALS

A. Provide the following in accordance with Section 01 3300, Submittal Procedures:

1. Provide documentation of ISO 9001 certification (if applicable).
2. Provide a copy of QA plan identifying procurement, design, fabrication, test and inspection, material traceability and non-conformity controls for approval by LANL prior to contract award
3. Catalog data and certificates of conformance (COC) for all instrumentation.
4. Provide CMTRs (alloy designations) for all process-wetted surfaces, consisting of legible copies of mill test reports indicating chemical analysis, physical test data, and heat number. COCs may be provided in lieu of CMTRs with prior LANL approval.
5. Calibration certification traceable to NIST standards for all instrumentation
6. Detailed installation instructions for the model of instrument supplied.
7. Functional test procedures and reports for all instrumentation.
8. Manufacturer's operation and maintenance instructions for the model of instrument supplied.
9. Helium leak test report for all instruments located outside the glovebox boundary and interfacing with the glovebox atmosphere. Provide test reports with signatures by personnel who either performed or witnessed the helium leak test and who hold either Level II or Level III certification in accordance with ASNT SNT-TC-1A.
10. Operating procedures, maintenance procedures, service schedules, recommended spare parts, and warranties.
11. Manufacturer's assembly drawings, wiring diagrams, and electrical schematics.

If a supplier is on a LANL approved vendor list, the supplier may not be required to submit a QA plan.

PART 2 PRODUCTS

Specific model numbers are listed as examples of accepted instruments. Specific manufacturers and model numbers may be substituted if another instrument provides equal or superior performance. When specific model numbers are no longer available, the criteria for materials and performance are to be used to specify a new model number.

2.1 MATERIALS

- A. Instruments installed in a radiation environment shall be constructed of appropriate materials. Fluoropolymers (Teflon, PTFE), Fluoroelastomers (Viton), and Tygon tubing are not to be used if these materials have the possibility of coming in contact with radiation.
- B. Instruments exterior to the enclosure shall use appropriate materials of construction between the instrument and the glovebox. Appropriate materials include stainless steel tubing or piping. Appropriate types of fittings include the use of compression type fittings (Swagelok), VCR fittings, or other Facility-approved fittings.

2.2 FIRE DETECTION SYSTEMS

- A. Heat Detectors
 - 1. Each glovebox and drop box containing a heat source (e.g., furnace) shall have a thermal detector in a stainless steel well with an alarm setpoint of 190°F.
 - 2. Each glovebox and drop box not containing a heat source shall have a thermal detector in a stainless steel well with an alarm setpoint of 140°F.
 - 3. Provide rate compensated, self-restoring thermal detectors that are UL listed and compatible with FACP.
 - 4. Material: Stainless steel shell sensing element.
 - 5. Manufacturer: Fenwal "Detect-A-Fire," Model 27021-0.

2.3 MOISTURE ANALYZERS

There are two primary types of moisture analyzers sensors: ceramic substrate and capacitance type. The ceramic substrate type has a fast response time and is resistant to corrosives. Additionally the sensor is exchangeable without needing recalibration. The accuracy of the sensor is also dependent on temperature, with large temperature ranges having a negative impact on the accuracy.

Capacitance type sensors have excellent chemical resistance and are resistant to condensing water. Capacitance type sensors often experience drifts in calibration over time, requiring the sensor to be recalibrated. The accuracy of the sensor is also dependent on temperature, with large temperature ranges having a negative impact on the accuracy.

- A. Moisture sensors shall be installed interior to the glovebox with a hermetically sealed electrical feedthrough to the moisture analyzer outside the glovebox.
 - 1. Ceramic Substrate
 - a. Sensing element: Metalized ceramic, sintered metal guard, NEMA 4X housing.
 - b. Probe Material: 316 stainless steel

- c. Power Requirements: 4 to 20 mA loop powered and 0 to 10 VDC outputs
- d. Dew Point Range: -148°F to 68°F
- e. Accuracy: $\pm 1.8^\circ\text{F}$ for -74° to 68°F, $\pm 3.6^\circ\text{F}$ for -148°F to -76°F
- f. Concentration Range: 0.001 to 9999 ppmv
- g. Outputs: 4 to 20 mA or EIA 485
- h. Process connection: 1/8 inch NPT
- i. Manufacturer: Kahn, Model: Cermet II Hygrometer

2. Capacitance

- a. Sensing element: Gold/Aluminum Oxide, NEMA 4X housing.
- b. Probe Material: 316 Stainless Steel
- c. Power Requirements: 0/1 to 5 VDC, 4 to 20 mA loop powered, or 4 to 20 mA.
- d. Dew Point Range: -202°F to 68°F
- e. Accuracy: $\pm 3.6^\circ\text{F}$ over the entire range
- f. Concentration Range: 0.001 to 9999 ppmv
- g. Outputs: 4 to 20 mA or EIA 485
- h. Process connection: 1/2 inch MNPT

Optional probe mountings are compression type fittings, VCR and other welded fittings.

- i. Manufacturer: Eastern Instruments Hydroguard, Model: MMY 2650

Oxygen analyzers used to sense oxygen concentrations of glovebox atmospheres consist of two basic types, electrochemical (non-depleting sensor) and galvanic (depleting sensor or fuel cell). Both types of oxygen analyzers have been used successfully at LANL glovebox facilities. Each type has advantages and disadvantages with regard to effectiveness, safety, and operation/maintenance requirements. It is incumbent of the author of this technical specification to weigh the advantages and disadvantages associated with each type before specifying an analyzer for use in gloveboxes.

Electrochemical-type oxygen analyzers consist of a non-depleting sensor, a sample pump, and an electronics package. These analyzers require a gas sample to be drawn from the glovebox, using the sample pump, so that constituents of the gas sample may react with the electrolyte

and inert cathode that form a part of the sensor. Standard electrochemical oxygen analyzers (not intended for glovebox operations) are typically supplied with the sensor, pump, and electronic package enclosed in a single electronics enclosure. The pump and sensor may often be plumbed with plastic tubing and barbed hose fittings, which are typically considered unacceptable for confinement of a contaminated gas sample. In addition, the pump supplied with the standard electrochemical oxygen analyzer may not have appropriate leak integrity and therefore may not be suitable for confinement of the gas sample. As a result, a customized oxygen analyzer should be specified for use with gloveboxes.

This specification describes three configurations of electrochemical-type oxygen analyzers for use with gloveboxes. The first configuration consists of placing a commercial, unmodified oxygen analyzer directly inside the glovebox. The second configuration consists of placing a commercial oxygen analyzer modified by the manufacturer outside the glovebox and drawing a sample from the box to the sensor. The third configuration consists of separating the pump and sensor (collectively known as a "remote sensor") from the electronics package and placing the remote sensor inside the glovebox and placing the electronics package outside the glovebox. The advantages and disadvantages of each configuration of electrochemical-type sensor are discussed in separate author's notes in Section 3 for all configurations described.

The advantages of using an electrochemical-type oxygen analyzer versus a galvanic-type oxygen analyzer for glovebox oxygen sensing include the following: 1) the anode forming a part of the sensor does not deplete when exposed to oxygen over time and therefore does not require replacement; 2) little or no re-calibration of the sensor is required; 3) large, transient, influxes of oxygen into the atmosphere being analyzed do not disrupt or deplete the sensor; and 4) a more rapid response to oxygen sensing is achievable since the gas sample path is in direct contact with the sensing cathode, unlike a galvanic sensor where a membrane and electrolyte separate the sample gas from the cathode.

The disadvantages of using an electrochemical-type oxygen analyzer for glovebox oxygen sensing include the following: 1) the electrolyte evaporates over time and must be replenished periodically; 2) an oxygen analyzer unmodified for glovebox use may need to be placed directly inside the glovebox to ensure proper confinement of glovebox gases; and 3) if space is not available within the glovebox the pump may be located outside the glovebox, however the sample streams must include filters and valves per facility standard and the sample pump must be enclosed within confined space to prevent the glovebox gases from escaping into the room.

Galvanic-type oxygen analyzers are susceptible to "oxygen shock" by being exposed to high oxygen concentrations. Oxygen shock will decrease the life of the oxygen analyzer and the sensor can take several hours to recover. As the sensor ages they tend to read false low oxygen concentrations, and as a result recalibration is required.

The main advantages of a galvanic-type analyzer are that they may be mounted in any position without affecting the accuracy of the sensor and they are not sensitive to vibration. Galvanic-type oxygen analyzers are less expensive than electrochemical-type oxygen analyzers. Galvanic-type analyzers also do not require a sample stream to be provided to the sensor.

2.4 OXYGEN ANALYZERS

A. Galvanic-type – No Sample Stream

1. Power Requirements: 4 to 20 mA loop powered
2. Range: 0-10,000 ppm
3. Accuracy: $\pm 2\%$ Full Scale

4. Process Wetted Materials: 316 Stainless Steel
5. Process connection: 1/8 inch NPT
6. Manufacturer: Panametrics, Model O2X1 Oxygen Transmitter

 Panametrics, Model O2X1 Oxygen Transmitter contains Viton O-rings and Teflon that would be exposed to glovebox gases. Upon ordering, substitute Viton O-rings with an appropriate material if in a radiation environment or enclose the entire sensor inside the glovebox.

B. Galvanic-type – Sample Stream Required – Analyzer Inside the Glovebox

 A pump to draw a gas sample is not integral to the Teledyne instrument.

1. Power Requirements: 4 to 20 mA loop powered
2. Range: 0-10,000 ppm
3. Accuracy: $\pm 2\%$ Full Scale
4. Connection: 1/2 inch NPT Hermetically sealed feedthrough the glovebox boundary.
5. Process Wetted Materials: 316 Stainless Steel
6. Process connection: 1/4 inch NTP
7. Manufacturer: Teledyne Electronic Technologies, Teledyne Analytical Model 3000TA

C. Galvanic-type – Sample Stream Required – Custom Fabrication

 In a customized fabrication the sensor and transmitter are located outside the glovebox. This configuration requires the manufacturer to provide helium leak tight containment of the process gas. A pump or vacuum system must provide the unit with a sample stream from the glovebox atmosphere.

A pump to draw a gas sample is not integral to the Teledyne instrument.

1. Power Requirements: 4 to 20 mA loop powered
2. Range: 0-10,000 ppm
3. Accuracy: $\pm 2\%$ Full Scale
4. Process Wetted Materials: 316 Stainless Steel
5. Process connection: 1/4 inch NPT
6. Manufacturer: Teledyne Electronic Technologies, Teledyne Analytical Custom Model 3000TA

D. Electrochemical-type – Analyzer Inside Glovebox

1. Outputs: 4 to 20 mA or EIA 485 Interface
2. Range: 0-10,000 ppm

3. Accuracy: $\pm 1\%$
4. Sample Flowrate: 0.5 to 1.5 lpm
5. Connection: 1/2 inch NPT Hermetically sealed feedthrough the glovebox boundary.
6. Process connection: 1/8 inch NPT, stainless steel
7. Manufacturer: Delta-F Platinum Series, Model: DF-350

E. Electrochemical-type – Customized Fabrication

In a customized fabrication the sensor and transmitter are located outside the glovebox. This configuration requires the manufacturer to provide helium leak tight containment of the process gas.

1. Outputs: 4 to 20 mA or EIA 485 Interface
2. Range: 0-10,000 ppm
3. Accuracy: $\pm 1\%$
4. Sample Flowrate: 0.5 to 1.5 lpm
5. Process connection: 1/8 inch NPT, stainless steel
6. Piping to and from the sensor requires filters and valves per facility standards.
7. Sensor exterior to the glovebox requires containment with a tested helium leak rate of no greater than 1×10^{-6} cc/sec
8. Manufacturer: Delta-F Platinum Series, Model: Customized DF-350

F. Electrochemical-type – Remote Sensor Configuration

1. Outputs: 4 to 20 mA or EIA 485 Interface
2. Range: 0-10,000 ppm
3. Accuracy: $\pm 1\%$
4. Sample Flowrate: 0.5 to 1.5 lpm
5. Connection: 1/2 inch NPT Hermetically sealed feedthrough the glovebox boundary
6. Manufacturer: Delta-F Platinum Series, Model: Model: DF-350 with remote sensor

Delete or edit the following section, which is likely unnecessary if 11 5311.16, Glovebox Feedthroughs Hermeneutically Sealed, is used and contains this information

G. Oxygen Analyzers – As supplied with regenerable purification systems

1. Provide integral oxygen analyzer with the purification unit to measure the oxygen concentration of the glovebox.

2. Refer to Section 11618 Glovebox Atmosphere Regenerable Purification Systems for oxygen analyzer options available with purification units.

2.5 PRESSURE INSTRUMENTS

A. Differential pressure gauges

1. Differential pressure gauges provide localized indication of the differential pressure between the glovebox and the laboratory work environment.

Differential pressure gauges are typically used to monitor the differential pressure between the glovebox and the laboratory work environment. These gauges can also be used to monitor the pressure drop across filters or other components associated with the glovebox. Information should be added as needed.

2. Accuracy: $\pm 2\%$ of full scale at 70°F (21 .1°C).
3. Range: 2-0-2 inch W.C. (For glovebox pressure) (15-0-15 inch W.C. Max range)
4. Rated Pressure: 15 psig
5. Blowout Protection: Relief plug opens at approximately 25 psig
6. Process connections: 1/8 inch NPT
7. Manufacturer: Dwyer Magnehelic Series 2000

B. Differential pressure gauges with switches

1. (Differential pressure gauges with switches provide localized indication of the differential pressure between the glovebox and the laboratory work environment with adjustable setpoints for local alarms). Provide these instruments on inert atmosphere boxes. The adjustable setpoints are used to control solenoid valves on the inert gas supply to the box and the bubbler bypass on the vent line.

Differential pressure gauges with switches are typically used to monitor the differential pressure between inert atmosphere gloveboxes and the laboratory work environment. The adjustable setpoints are typically used to control solenoid valves on the gas supply to an inert box and the bubbler bypass. These gauges can also be used to monitor the pressure drop across filters or other components associated with the glovebox. Information should be added as needed. Filters are not to be installed between the glovebox and the differential pressure instrument since the filter could dampen the response time of the instrument. Photohelic gauges installed at CMR should be capable of sending three signals: 1) local (room), 2) regional (wing corridor, and 3) central (operations center) per CMR-SDD-007, R00.

2. Accuracy: $\pm 2\%$ of full scale at 70°F (21 .1°C).
3. Range: 2-0-2 inch W.C. (For glovebox pressure) (15-0-15 inch" W.C. Max range).
4. Rated Pressure: -20" Hg. to 25 psig (-.67 to 1.7 bar).
5. Power Required: 120 VAC, 60 Hz

6. Electrical Rating of Alarm Relays (total of 2 available): 10 Amps @ 120 VAC
7. Process Connections: 1/8 inch NPT
8. Gauges with ranges of 5 inch W.C. or less shall be factory calibrated for use with the scale in the vertical position.
9. Manufacturer: Dwyer Photohelic Series A3300

C. Pressure Gauges

The pressure gauge specified is used to measure the pressure of a gas utility to a glovebox. This section does not include pressure gauges that are integral to pressure regulating valves, however this section can be modified to include such instruments.

1. Accuracy: $\pm 1\%$ of full span
2. Material: Stainless Steel Case, Stainless Steel Fitting
3. Wetted Material: 316 Stainless Steel
4. Liquid Fill: Glycerin or Silicon
5. Range: Specified by user at time of design.
6. Process Connections: 1/4 inch MNPT
7. Manufacturer: Ametek, Model 545L or Tescom, Model: Series 4802

2.6 TEMPERATURE INSTRUMENTS

- A. Feedthroughs for thermocouples inside gloveboxes
 1. Provide Douglas Engineering PN 42800 feedthrough with Marlin PN 1030-5-K thermocouple plate on both sides.
- B. Thermocouples
 1. ANSI Type K (chromel-alumel) Element
 2. Temperature Range: -270 to 1370°C.
 3. Standard Limit of Error: 4°F or 0.75%
 4. Manufacturer: Facility Approved
- C. Temperature Indicators/Transmitters
 1. Range: -270 to 1370°C.
 2. Input: K Type thermocouple
 3. Output: 4 to 20 mA or EIA 485
 4. Manufacturer: Watlow Model 8LS

2.7 HYDROGEN CHLORIDE MONITORS

The HCl sensor should be located close to the bottom of an air or nitrogen atmosphere glovebox due to the fact that HCl has a higher density than nitrogen or air. In an argon atmosphere glovebox, hydrogen chloride has a lower density than argon and sensor should

subsequently be located on the top of the glovebox. Sensor may be specified integral with the transmitter or the sensor may be separate from the transmitter. In the first configuration the output signal is transmitted through a hermetically sealed feedthrough. In the second configuration, the signal from the sensor is transmitted through a hermetically sealed feedthrough to the transmitter outside the glovebox boundary.

Electrochemical sensors function by allowing the sample gas to diffuse through a membrane, reacting the gas at the electrolyte and catalyst interface and producing current. The current is measured by the instrument and converted to a gas concentration. The warm up period is important to consider when selecting an instrument. A majority of electrochemical sensors require a fixed bias to maintain the temperature of the sensor. The sensors with a built in battery bias remain "hot" eliminating warm up time. Flowrate of greater than 1 lpm can change the diffusion characteristics of the gas being monitored. If the sensor is located in an area where the flowrate is higher than 1 lpm, consult the manufacturer on possible systems to accommodate the higher flowrate.

- A. Sensor type: Electrochemical
- B. Output: 4 to 20 mA or EIA 485
- C. Power Requirements: 4600 2 wire, 4-30 VDC
- D. Accuracy: $\pm 2\%$ of full range
- E. Sensor Housing Material: stainless steel
- F. Range: 0-100 ppm
- G. Bias: Built in battery
- H. Connection: 1/2 inch NPT Hermetically sealed feedthrough at the glovebox boundary.
- I. Manufacturer: Scott Instruments model 4671-55-1-4-1-1 (4-20 mA output with integral sensor), model 4671-55-2-4-1-1 (4-20 mA output, sensor and transmitter are separated).

2.8 HYDROGEN FLUORIDE MONITORS

The user shall consider the relative density of HF and the glovebox atmosphere and place the HF sensor inside the glovebox in a position where HF is likely to accumulate See 3.1.Q.1&2 for installation locations that depend on atmosphere. Sensor may be specified integral with the transmitter or the sensor may separate from the transmitter. In the first configuration the output signal is transmitted through a hermetically sealed feedthrough. In the second configuration, the signal from the sensor is transmitted through a hermetically sealed feedthrough to the transmitter outside the glovebox boundary.

Electrochemical sensors function by allowing the sample gas to diffuse through a membrane, reacting the gas at the electrolyte and catalyst interface and producing current. The current is measured by the instrument and converted to a gas concentration. The warm up period is important to consider when selecting an instrument. A majority of electrochemical sensors require a fixed bias to maintain the temperature of the sensor. The sensors with a built in battery bias remain "hot" eliminating warm up time. Flowrate of greater than 1 lpm can change the diffusion characteristics of the gas being monitored. If the sensor is located in an area

where the flowrate is higher than 1 lpm, consult the manufacturer on possible systems to accommodate the higher flowrate.

- A. Sensor type: Electrochemical
- B. Output: 4 to 20 mA or EIA 485
- C. Power Requirements: 4600 2 wire, 4-30 VDC
- D. Accuracy: $\pm 2\%$ of full range
- E. Sensor Housing Material: Stainless Steel
- F. Range: 0-20 ppm
- G. Bias: Built in battery
- H. Connection: 1/2 inch NPT Hermetically sealed feedthrough at the glovebox boundary.
- I. Manufacturer: Scott Instruments model 4670-40-1-4-1-1 (with integral sensor), model 4670-40-2-4-1-1 (sensor and transmitter are separated).

2.9 CHLORINE MONITORS

The sensor should be located close to the bottom of the glovebox due to the fact that Chlorine has a higher density than air, nitrogen and argon. Sensor may be specified integral with the transmitter or the sensor may separate from the transmitter. In the first configuration the output signal is transmitted through a hermetically sealed feedthrough. The second configuration, the signal from the sensor is transmitted through a hermetically sealed feedthrough to the transmitter outside the glovebox boundary.

Electrochemical sensors function by allowing the sample gas to diffuse through a membrane, reacting the gas at the electrolyte and catalyst interface and producing current. The current is measured by the instrument and converted to a gas concentration. The warm up period is important to consider when selecting an instrument. A majority of electrochemical sensors require a fixed bias to maintain the temperature of the sensor. The sensors with a built in battery bias remain "hot" eliminating warm up time. Flowrate of greater than 1 lpm can change the diffusion characteristics of the gas being monitored. If the sensor is located in an area where the flowrate is higher than 1 lpm, consult the manufacturer on possible systems to accommodate the higher flowrate.

- A. Sensor type: Electrochemical
- B. Output: 4 to 20 mA or EIA 485
- C. Power Requirements: 4600 2 wire, 4-30 VDC
- D. Accuracy: $\pm 2\%$ of full range
- E. Sensor Housing Material: stainless steel
- F. Range: 0-100 ppm
- G. Bias: Built in battery
- H. Connection: 1/2 inch NPT Hermetically sealed feedthrough at the glovebox boundary.

- I. Manufacturer: Scott Instruments model 4652-55-1-4-1-1 (with integral sensor), model 4652-55-2-4-1-1 (sensor and transmitter are separated)

2.10 HYDROGEN MONITORS

Electrochemical sensors function by allowing the sample gas to diffuse through a membrane, reacting the gas at the electrolyte and catalyst interface and producing current. The current is measured by the instrument and converted to a gas concentration. The warm up period is important to consider when selecting an instrument. A majority of electrochemical sensors require a fixed bias to maintain the temperature of the sensor. The sensors with a built in battery bias remain "hot" eliminating warm up time. Flowrate of greater than 1 lpm can change the diffusion characteristics of the gas being monitored. If the sensor is located in an area where the flowrate is higher than 1 lpm, consult the manufacturer on possible systems to accommodate the higher flowrate.

Sensors are to be located close to the top of the glovebox due to the fact that hydrogen has a lower density than air, nitrogen or argon. Sensor may be specified integral with the transmitter or the sensor may separate from the transmitter. In the first configuration the output signal is transmitted through a hermetically sealed feedthrough. The second configuration, the signal from the sensor is transmitted through a hermetically sealed feedthrough to the transmitter outside the glovebox boundary.

Thermal conductivity type analyzers measure the concentration of a binary gas mixture based on the specific heat capacity of each gas. Thermal conductivity type analyzers are better suited in process lines since a sample stream is required for accurate measurement. If used on a glovebox a separate sample pump would be required. A facility vacuum system may be used to draw a sample to the sensor. The contamination level of the glovebox and vacuum system must be considered for this configuration. This sensor should not be used if more than two gases are present or have the potential of being present.

A. Electrochemical-type

1. Output: 4 to 20 mA or EIA 485
2. Power Requirements: 4600 2 wire, 4-30 VDC
3. Accuracy: $\pm 2\%$ of full range
4. Sensor Housing Material: Stainless Steel

Panametrics Model TMO2-TC contains Viton O-rings that would be exposed to glovebox gases. When ordering substitute Viton O-rings with an appropriate material if in a radiation environment or enclose the entire sensor inside the glovebox.

5. Range: 0 to 2%(by weight, minimum)
6. Alarm to be set at 25% of LEL.
7. Connection: 1/2 inch NPT hermetically sealed feedthrough at the glovebox boundary
8. Manufacturer: Scott Instruments Model 4687-1D-1-4-1-1 (with integral sensor), model 4687-1D-2-4-1-1 (sensor and transmitter are separated)

B. Thermal conductivity-type

1. Output: 4 to 20 mA or EIA 485
2. Power Requirements: Loop Powered
3. Accuracy: $\pm 2\%$ of full range
4. Wetted Materials: 316 stainless steel, glass and Viton O-rings

Panametrics, Model TMO2-TC contains Viton O-rings, which would be exposed to glovebox gases. Upon ordering substitute Viton O-rings with an appropriate material if in a radiation environment or enclose the entire sensor inside the glovebox.

5. Range: 0 to 2%(by weight, minimum)
6. Sample flowrate: 0.1 to 4.0 scfh.
7. Alarm set at 25% of LEL
8. Process Connection(s): TMO2-TC requires two 1/4 inch FNPT connectors
9. Manufacturer: Panametrics Model TMO2-TC

2.11 MISCELLANEOUS INSTRUMENTS

This section is dedicated for miscellaneous instruments used inside the glovebox. Information should be added as needed. Specifications should include power requirements, communication capability, range, accuracy, process connections, materials, sample flowrates, manufacturer, and model number.

PART 3 EXECUTION

3.1 INSTALLATION

Instruments installed on gloveboxes that are considered "hot" are not to be helium leak tested post installation. Only visual inspection is required.

- A. Ensure all process connections to the glovebox are helium leak tight. Refer to Section 11 5311.10 Glovebox Fabrication for helium leak test requirements.
- B. Install instruments in accordance with the manufacturer's installation instructions and facility requirements.
- C. Instruments with an NPT connection shall be installed per manufacturer requirements. Minimum basic requirements include: Verify that threads are clean, torque "snug tight" using Teflon tape and "Tru Blu" adhesive. Do not over tighten the instrument or use the instrument housing itself for tightening purposes.
- D. Heat detectors

1. Install thermal detectors on the top of the glovebox in a LANL approved well, in accordance with LANL drawing 26Y-202010.
2. Refer to Section 11616 for hermetically sealed feedthrough requirements.

E. Moisture analyzers

1. Install moisture sensors interior to the glovebox with a hermetically sealed electrical feedthrough to the moisture analyzer outside the glovebox. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements.

F. Oxygen Analyzer Electrochemical-type – Analyzer Inside the glovebox

1. Install a gas scrubber, adsorber or other appropriate guard to protect the sensor from degradation when acid gases are present.
2. Provide a sample stream from the glovebox atmosphere to flow through the oxygen analyzer.

At TA-55 drawing a sample using the house dry vacuum can eliminate the sample pump. A glovebox that has the potential to be contaminated cannot be tied into an uncontaminated vacuum system to draw a sample stream.

3. The process sample stream can be drawn into the facility vacuum system of equal contamination level. If the glovebox is free from radiation (i.e. a cold glovebox) then the sample stream should not be connected to the facility vacuum system to prevent contamination. Associated piping shall have facility required valves and filters between the instrument and a contained area.

Placing a commercial analyzer inside the glovebox eliminates any concern with leak integrity of the sensor and pump. Primary considerations are if the process inside the glovebox is sensitive to water, the sample exhaust must be vented out of the glovebox in an appropriate manner. The water is introduced into the glovebox by evaporating the distilled water in the sensor. Evaporation rates may be as high as 50 mL for every 6 months. Appropriate filters and valves must be installed on the sample pump exhaust if it penetrates the glovebox wall.

G. Oxygen Analyzer Electrochemical-type – Customized Fabrication

1. Install a gas scrubber, adsorber or other appropriate guard to protect the sensor against degradation when acid gases are present.
2. Provide a sample stream from the glovebox atmosphere to flow through the oxygen analyzer.
3. The installation of a pump to draw a sample stream outside the glovebox including associated pipe shall have a helium leak rate not to exceed 1×10^{-6} std cc/sec. Associated piping shall have facility required valves and filters between the instrument and a contained area

At TA-55 drawing a sample using the house dry vacuum can eliminate the sample pump. A glovebox that has the potential to be contaminated cannot be tied into an uncontaminated vacuum system to draw a sample stream.

4. The process sample stream can be drawn into the facility vacuum system of equal contamination level. If the glovebox is free from radiation (i.e. a cold glovebox) then the sample stream should not be connected to the facility vacuum system to prevent contamination. Associated piping shall have facility required valves and filters between the instrument and a contained area

Installing a commercially available oxygen analyzer outside the glovebox requires filters and valves to be installed on the sample inlet to analyzer per facility standards. Primary considerations are if the process inside the glovebox is sensitive to water, the sample exhaust must be vented to the appropriate glovebox vent system and not back into the glovebox. The water is introduced into the sample stream outlet by evaporating the distilled water in the sensor. Evaporation rates may be as high as 50 mL for every 6 months. Appropriate filters and valves must be installed on the sample pump exhaust before connecting into the appropriate glovebox ventilation system.

This configuration consists of a containment system around the oxygen analyzer that has a tested helium leak rate no greater than 1×10^{-6} std cc/sec. Venting a containment system and providing maintenance access to the oxygen analyzer would also need to be considered.

5. Piping to and from the sensor requires filters and valves per facility standards.
 6. Sensor exterior to the glovebox requires containment with a tested helium leak rate of no greater than 1×10^{-6} std cc/sec.
- H. Oxygen Analyzer Electrochemical-type – Remote Sensor Configuration
1. Install a gas scrubber, adsorber or other appropriate guard to protect the sensor from degradation when acid gases are present.
 2. Provide a sample stream from the glovebox atmosphere to flow through the oxygen analyzer.
 3. The installation of a pump to draw a sample stream outside the glovebox including associated pipe must have a helium leak rate not to exceed 1×10^{-6} std cc/sec. Associated piping shall have facility required valves and filters between the instrument and a contained area.

At TA-55 drawing a sample using the house dry vacuum can eliminate the sample pump. A glovebox that has the potential to be contaminated cannot be tied into an uncontaminated vacuum system to draw a sample stream.

4. The process sample stream can be drawn into the facility vacuum system of equal contamination level. If the glovebox is free from radiation (i.e. a cold glovebox) then the sample stream should not be connected to the facility vacuum system to prevent contamination. Associated piping shall have facility required valves and filters between the instrument and a contained area.

Analyzers configured remotely eliminate any concern with leak integrity of the sensor and pump. Primary considerations are if the process inside the glovebox is sensitive to water, the sample exhaust must be vented out of the glovebox in an appropriate manner. The water is introduced into the glovebox by evaporating the distilled water in the sensor. Evaporation rates may be as high as 50 mL for every 6 months. Appropriate filters and valves must be installed on the sample pump exhaust if it penetrates the glovebox wall.

This configuration places the pump and sensor inside the glovebox with the display/transmitter outside the glovebox. A hermetically sealed feedthrough is required at the glovebox boundary for the sensor signal; refer to Section 11 5311.16.

5. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements to pass the output signal through the glovebox boundary.
 - I. Galvanic-type – No sample stream
 1. Oxygen sensor and transmitter shall be located inside the glovebox.
 2. Connect output cable to a hermetically sealed to pass the output signal through the glovebox boundary. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements.
 - J. Galvanic-type – Sample Stream Required – Analyzer Inside the Glovebox

At TA-55 drawing a sample using the house dry vacuum can eliminate the sample pump. A glovebox that has the potential to be contaminated cannot be tied into an uncontaminated vacuum system to draw a sample stream.

1. Provide process sample stream piping. The stream can be drawn into the facility vacuum system of equal contamination level. If the glovebox is free from radiation (i.e. a cold glovebox) then the sample stream should not be connected to the facility vacuum system to prevent contamination. Associated piping shall have facility required valves and filters between the instrument and a contained area.
 2. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements to pass the output signal through the glovebox boundary.
- K. Galvanic-type – Sample stream required – Custom Fabrication

At TA-55 drawing a sample using the house dry vacuum can eliminate the sample pump. A glovebox that has the potential to be contaminated cannot be tied into an uncontaminated vacuum system to draw a sample stream.

Installing a commercially available oxygen analyzer outside the glovebox requires filters and valves to be installed on the sample inlet to analyzer per facility standards. Appropriate filters and valves must be installed on the sample pump exhaust before connecting into the appropriate glovebox ventilation system.

This configuration consists of a containment system around the oxygen analyzer that has a tested helium leak rate no greater than 1×10^{-6} std cc/sec. Venting a containment system and providing maintenance access to the oxygen analyzer would also need to be considered.

1. Calibrate analyzer before putting into operation.
2. The installation of a pump to draw a sample stream outside the glovebox including associated pipe shall have a helium leak rate not to exceed 1×10^{-6} std cc/sec. Associated piping shall have facility required valves and filters between the instrument and a contained area.

L. Differential pressure gauges

1. Install the gauge exterior to the glovebox with a process connection at the glovebox wall.
2. Before installation, "zero" the gauge.
3. Install a LANL approved inline filter between the glovebox and the gauge.

M. Differential pressure gauges with switches

1. The gauge is installed exterior to the glovebox with a process connection at the glovebox wall.
2. Before installation, "zero" the gauge.
3. Functionally test the instrument to verify the switches actuate the inert gas and bubbler bypass solenoid valves
4. NOTE: Gauges with ranges of 5 inch W.C. or less are ordered factory calibrated.

N. Pressure gauges

1. Install gauges. NOTE: Pressure gauges are calibrated for use in a vertical and upright position; if to be mounted sideways, horizontal or upside down, recalibrate the pressure gauge before use.
2. Pressure gauges shall be installed on all gas utilities to gloveboxes. Provide gauges after all pressure regulators.

O. Temperature Instruments

Thermocouples can be installed using a wide range of methods dependent on the specific application and temperature range being measured. The following list of possible installation applications is a partial list of installations. Consult with the supplier for additional configurations.

1. Ring Terminal Style: The terminal is placed beneath an existing screw to accurately measure the surface temperature.
2. Pipe Clamp Style: A stainless steel pipe clamp allows measurement of a pipe temperature without tapping or drilling the pipe.

3. Grommet Style: Low profile of a stainless steel grommet provides fast response time.
4. Shim Style: Provides a low profile and can be installed between two surfaces to measure the temperature. This style is available in a variety of materials.
5. Kapton Peel and Stick Thermocouple: Thermocouple is attached with a self adhesive film to bond the surface of the material being measured for temperatures up to 400°F.

P. Hydrogen chloride monitors

1. Sensors shall be located within close proximity of the bottom of glovebox in an air or nitrogen atmosphere glovebox.
2. Sensors shall be located within close proximity of the top of the glovebox in an argon atmosphere glovebox.
3. The sensor shall be pointed downwards or 90° from vertical (the sensor should never be pointed upwards).
4. Avoid strong electromagnetic fields; exposure to such fields may cause false readings.
5. Refer to Section 11616 for hermetically sealed feedthrough requirements to pass the output signal through the glovebox boundary.

Q. Hydrogen Fluoride monitors

1. Sensors shall be located within close proximity of the bottom of glovebox in an air or nitrogen atmosphere glovebox.
2. Sensors shall be located within close proximity of the top of the glovebox in an argon atmosphere glovebox.
3. The sensor shall be pointed downwards or 90° from vertical (the sensor should never be pointed upwards).
4. Avoid strong electromagnetic fields; exposure to such fields may cause false readings.
5. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements to pass the output signal through the glovebox boundary.

R. Chlorine monitors

1. Sensors shall be located within close proximity of the bottom of glovebox in an air, nitrogen or argon atmosphere glovebox.
2. The sensor shall be pointed downwards or 90° from vertical (the sensor should never be pointed upwards).
3. Avoid strong electromagnetic fields; exposure to such fields may cause false readings.
4. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements to pass the output signal through the glovebox boundary.

S. Hydrogen monitors

1. NOTE: Hydrogen monitors are typically installed in air gloveboxes when the production of hydrogen is possible or on process lines that have the potential for both oxygen and hydrogen to be present at the same time.

2. Install the sensor in close proximity of the top of the glovebox for the sampling of the glovebox atmosphere.
3. Electrochemical-type
 - a. The sensor shall be pointed downwards or 90° from vertical (the sensor should never be pointed upwards).
 - b. Avoid strong electromagnetic fields; exposure to such field may cause false readings.
4. Thermal Conductivity
 - a. Provide a sample stream to the instrument.
 - b. Thermal conductivity analyzers shall be used when there are only two gases present.
5. Refer to Section 11 5311.16 for hermetically sealed feedthrough requirements to pass the output signal through the glovebox boundary.

T. Miscellaneous instruments

 Include specific installation instructions and requirements as provided by the manufacturer.

3.2 FIELD QUALITY CONTROL

A. Receipt Inspection Requirements

1. Verify correct model number with submitted design and required vendor documentation.
2. Prior to release for installation the instrument shall be visually inspected for cracks, dents, and other abnormalities that could affect the accuracy of the instrument.

B. Protection

1. Protect galvanic oxygen analyzers per manufacturer's instructions from high oxygen concentrations before installation.
2. HF, HCl₂, Cl, and H₂ gas analyzers shall be protected for excessive shock or vibrations before and after installation.

C. Test Out

1. Functionally test all instrumentation in accordance with an approved test procedure.
 - a. Instruments installed on a commissioned glovebox shall be tested prior to installation.
 - b. Instruments installed on a new glovebox prior to commissioning shall be tested after installation on the glovebox.
2. Functionally test the thermal detector for alarm activation and active initiation of protective features in accordance with an approved test

procedure. Heat detectors installed on gloveboxes located in TA-55 shall be tested per NMT-8-ASI-006, "Fire Alarm Initiating Device Inspection, Maintenance, and Testing."

3. Gas analyzers require calibration by LANL prior to being put into service.

D. Leak test

1. New Gloveboxes

a. Helium leak test all process connections per ASTM E499. Pressure during helium leak test to be +10" W.C.

2. Commissioned Gloveboxes

a. Visually inspect all process connections.

3.3 SCHEDULES

Include a schedule of instrument assignments to particular gloveboxes.

END OF SECTION

Do not delete the following reference information:

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 11 5311.17 Rev. 0, dated January 6, 2006.